WARM-UP B

READ MY DATA

Most environmental decisions and regulations are based upon large quantities of numerical data and trends. This exercise introduces students to the fundamentals of reading and analyzing data and extracting comparisons and averages. It can be delivered by the teacher or a guest presenter, or by both together. It is related to the "Breathing Room," "The Greenhouse Effect," and "Smog" activities.

CRITICAL OBJECTIVES

- Understand how data is collected and analyzed
- Recognize air pollutants the government requires to be monitored

SKILLS

- Computing
- Analyzing data

GUEST PRESENTERS

Guest presenters could include air quality engineers, environmental scientists, EPA risk assessment specialists, EPA environmental protection specialists, meteorologists, or statisticians.

BACKGROUND

No matter where you live, but especially in urban areas, each breath you take contains gases or particles that may be unhealthy. We know this from the analysis of air quality data from around the country. We also know that much of the air pollution is invisible and cannot be detected by human senses. Realistically, in our industrial society, it is not practical to expect that air pollutants can be eliminated totally anywhere, so it becomes important to determine what "acceptable" concentrations will be allowed, and equally important to monitor ambient air quality so that these "acceptable" limits are not exceeded. Most air quality monitoring is done automatically by specialized equipment located strategically throughout the country. These monitoring stations collect vast quantities of data and create a record of the concentrations and durations of specific pollutants. The Clean Air Act establishes certain "standards," or acceptable levels, for various "criteria" pollutants. Most laws and regulations have separate standards for averaged concentrations over certain short- and long-terms (such as maximum 8-hour average concentrations). The Clean Air Act establishes National Ambient Air Quality Standards for six criteria pollutants: carbon monoxide, sulphur dioxide, nitrogen oxides, ozone, particulate matter, and lead. The short-term National Ambient Air Quality Standards (NAAQS) for several pollutants are shown on the accompanying table.

RELATED ACTIVITIES
5, 12, 14

REFER TO READING MATERIALS
"The Clean Air Act"
"Air Pollution"

TARGET GRADE LEVEL
5th-12th

DURATION
40 minutes (or additional session with guest presenter)

VOCABULARY
Air quality monitoring
Ambient air
Data
Pollutant
Standards
Trend

MATERIALS
Paper
Pencils

WORKSHEETS INCLUDED
2

This exercise will look at concentrations for the first four pollutants in several cities around the country. Just how clean is your air? You could guess—but check the accompanying data and find out. (See reading materials on "The Clean Air Act," and "Air Pollution.")

WHAT TO DO

1. Write "1 ppm" on the chalkboard, and next to it write the fraction:

$$\frac{1}{1{,}000{,}000}$$

   Explain that "ppm" means "parts per million" and is similar to "percent" in that "percent" means "parts per hundred." Explain that, like "percent," ppm has no units or dimensions (such as grams or cubic meters). Challenge the class to state which quantity is smaller, 1 ppm or 1 percent. For older students, ask them to compute how much smaller 1 ppm is than 1 percent. Point out that since there are 10,000 "hundreds" in a million, 1 ppm must be 10,000 times smaller than 1 percent.

2. Using Student Worksheet 1, explain to the class what the numbers represent and ask the students to answer the questions. (For more advanced students, request the answers in quantitative terms.)

3. Using Student Worksheet 2, direct the students to calculate the percentage change in pollutant concentrations from 1975 to 1991 for the listed pollutants. Call students' attention to the fact that two of the six pollutants have units of $\mu g/m^{3,}$ which means micrograms per cubic meter, while the other four pollutants have units of ppm, or parts per million. Explain to them that both represent concentrations of pollutants in the air. The four ppm pollutants are all gases, and most fluids (gases and liquids) normally have concentrations expressed as milliliters per liters (part per thousand) or microliters per liter (parts per million). Lead and particulates are solids, and their density cannot be arbitrarily established in relation to air. Therefore, their concentrations are normally expressed as a unit of weight (mass) per volume of air. The difference in the units of measure does not affect the calculation of percentage change.

4. Ask the students to identify significant changes. Have them speculate as to why the changes might have occurred. Discuss their answers with the guest speaker.

5. Point out to the students that the standards are very different from each other. Ozone's permissible level, for instance, is 75 times lower than that of carbon monoxide. Ask the class to speculate why the standards may be different for different substances. Explain that the human health tolerances are different for each pollutant and each pollutant may cause different health effects. The regulations account for these differences.

Suggested Modifications

- Call your Regional EPA contact (see the Project A.I.R.E. Contacts listed at the back of this package) for information about where to obtain similar data for your geographic location. Conduct a similar analysis.

Suggested Reading

Baines, John. *Conserving Our World, Conserving the Atmosphere*. Austin, TX: Steck-Vaughn Company (1990).

Gay, Kathlyn. *Acid Rain*. New York: Franklin Watts (1983).

Pollution (Science Kit). Delta Education (1990).

STUDENT WORKSHEET 1

READ MY DATA

MAJOR AIR POLLUTANTS FOR SELECTED CITIES IN THE UNITED STATES — 1991

City	Carbon monoxide*	Ozone**	Sulphur Dioxide***	Nitrogen Oxides***
(National Standards)	**9 ppm**	**0.12 ppm**	**0.030 ppm**	**0.053 ppm**
Atlanta	7	0.13	0.008	0.025
Boston	4	0.13	0.012	0.035
Chicago	6	0.13	0.019	0.032
Detroit	8	0.13	0.012	0.022
Houston	7	0.20	0.007	0.028
Indianapolis	6	0.11	0.012	0.018
Los Angeles	16	0.31	0.005	0.055
New Orleans	4	0.11	0.005	0.019
New York City	10	0.18	0.018	0.047
Pittsburgh	6	0.12	0.024	0.031
San Francisco	8	0.07	0.002	0.031
St. Louis	7	0.12	0.016	0.026

* Second highest 8-hour average
** Second highest 1-hour average
*** Yearly average

1. **Which cities have carbon monoxide levels above the National Standards? Express the answers in percentages over or under the limit.**

   For example, New York's 10 ppm is

   (10 - 9) ÷ 9 = 1/9 = 0.111 = 11% over the National Standard.
   (data - permissible limit) ÷ (permissible limit) = ? x 100 = % over limit

2. **Speculate why any of the cities would exceed the permissible limits.**

3. **Do the same for the other three air pollutants.**

STUDENT WORKSHEET 2

READ MY DATA

CHANGES IN AVERAGE CONCENTRATION POLLUTANTS IN THE UNITED STATES — 1975-1991

Pollutant	1975	1991	% Change	
Carbon Monoxide	10 ppm	6 ppm	______	Show increase with plus (+) sign and decrease with a minus (-) sign in front of percentage.
Lead	0.68 $\mu g/m^3$	0.048 $\mu g/m^3$	______	
Nitrogen Oxides	0.021 ppm	0.021 ppm	______	
Ozone	0.147 ppm	0.115 ppm	______	
Particulates	63 $\mu g/m^3$	47 $\mu g/m^3$	______	
Sulphur Dioxide	0.0132 ppm	0.0075 ppm	______	

Source: United States Environmental Protection Agency, *National Air Quality and Emissions Trends Reports*. 1981 and 1991

Calculate the percentage change for each pollutant. To do this, subtract the 1991 value from the 1975 value (to get the actual difference), then divide that answer by the 1975 value, to get the percentage change since 1975.

1. **What was the percentage change (either increase or decrease) in each pollutant for each city from 1975 to 1991?**

   For example, sulphur dioxide went down by 43%:

   (0.0132 - 0.0075) ÷ 0.0132 = 0.4318 x 100 = 43.18%
   (rounded to 43%)
   (1975 value - 1991 value) ÷ (1975 value) = ? x 100 = % change

   Round your answers to whole percentages.

2. **Did any pollutant concentrations go up?**

3. **Which pollutant changed the most?**